In Vivo 3D representation of the Levator Ani Muscle Using Diffusion Tensor Imaging with fiber tractography: Initial Results

Aims of the study
The aims of this preliminary study are to demonstrate the feasibility of providing in vivo 3D architecture of the human levator ani muscle (LA) and to assess the value of tractography images to obtain averaged microstructural parameters, i.e., the fractional anisotropy (FA) and the apparent diffusion coefficient (ADC).

Material and Methods
Ten young female volunteers underwent diffusion tensor imaging (DTI) at 1.5T MRI (Achieva, Philips Medical System) with additional T2 weighted multisequences for anatomical reference. Muscular tractography was performed for each of the three right and left major subdivisions muscles of the LA and the obturator internus muscle. The left muscle was chosen as the reference muscle of the pelvis. Number of numeric fibers, a scoring system of relevance of the 3D representation (from 3 to 0), FA and ADC have been calculated.

Results
Data analysis was possible for all but 2 volunteers. The mean quantitative and qualitative data are reported in the table.

The score of relevance of the 3D representation was considered as correct (score=2), acceptable (score=1) and inaccurate (score=0) respectively for the pubovisceral (Fig 1), puborectal (Fig 2) and iliococcygeus (Fig 3) muscles and as good (score=3) for the obturator internus muscle (Fig 4).

The mean FA values ranged from 0.42 +/-1.0.1.043 +/-0.02 and 0.41 +/-0.15, and the mean ADC values were 1.36 +/-0.05; 1.36 +/-0.06 and 1.51 +/-0.07 respectively for the pubovisceral, puborectal and iliococcygeus muscles. For the obturator internus muscle, the mean values were 0.36 +/-0.15 and 1.48 +/-0.5 respectively for the FA and the ADC.

Table: Mean quantitative and qualitative data for each muscle of 8 volunteers.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Total number of fibers</th>
<th>Number of inaccurate fibers</th>
<th>Number of well-organized fibers</th>
<th>Score of relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pubovisceral</td>
<td>21 +/-1</td>
<td>6 +/-1</td>
<td>15 +/-1</td>
<td>1.8 +/-0.1</td>
</tr>
<tr>
<td>Puborectal</td>
<td>20 +/-2</td>
<td>7 +/-1</td>
<td>13 +/-1</td>
<td>1.3 +/-0.2</td>
</tr>
<tr>
<td>Iliococcygeus</td>
<td>14 +/-1</td>
<td>14 +/-1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Obturator internus</td>
<td>89 +/-5</td>
<td>7 +/-1</td>
<td>82 +/-5</td>
<td>2.8 +/-0.1</td>
</tr>
</tbody>
</table>

Each value is presented mean +/-SEM

Interpretation of results
The study of the pubovisceral and puborectal muscle of the LA is possible with a 3D representation using DTI with fiber tractography. Although, the study of the iliococcygeus muscle is more difficult probably due to the thinness of the muscle and technical limits. Good results for the obturator internus muscle demonstrate that DTI with fiber tractography is valuable in the study of pelvic muscle.

Conclusion
This study demonstrates the feasibility of visualizing at least two of the three subdivisions muscles of the complex LA architecture with a 3D representation using 1.5T DTI with fiber tractography.